Supplementary Material

The new Swiss Glacier Inventory SGI2016: From a Topographical to a Glaciological Dataset

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The Supplementary Material contains 8 additional Tables and 2 Figures supporting the compilation and interpretation of the Swiss Glacier Inventory 2016 (SGI2016).

Table S1: *Links to examples for different aspects of debris-cover classification in all major river catchments A, B, C and E with glaciers, classified by types, a) debris-covered glacier tongue, b) medial and lateral moraines and c) emerging debris-covered glacier margins and diffuse areas. Areas classified as debris-covered are hatched and the SGI2016 glacier outline is shown. The coordinates (X, Y) refer to the Swiss reference system CH1903+/LV95.*

	Glacier name / Location	*Type*	*X*	*Y*	*Link*
A	Im Griess	a)	2'708'972.5	1'190'063.7	https://s.geo.admin.ch/91f3e125d9
A	Wallenburfirn	a)	2'678'914.0	1'173'311.0	https://s.geo.admin.ch/91f3dddc19
B	Grosser Aletschgletscher	b)	2'645'885.0	1'150'107.5	https://s.geo.admin.ch/91f3d8ae32
B	Fieschergletscher	b)	2'654'052.0	1'147'389.0	https://s.geo.admin.ch/91f3d61881
B	Griesgletscher	c)	2'668'740.0	1'143'332.5	https://s.geo.admin.ch/91f492c8b6
B	Zmuttgletscher	a)	2'614'870.0	1'093'722.5	https://s.geo.admin.ch/91f491ac9d
B	Glacier du Mont Durand	a), b)	2'591'735.0	1'085'708.7	https://s.geo.admin.ch/91f48ff6d7
C	Vadrec da l'Albigna	a), c)	2'769'840.0	1'130'427.5	https://s.geo.admin.ch/91f489d230
E	Vadret da Grialetsch	c)	2'793'646.0	1'174'571.0	https://s.geo.admin.ch/91f48ca7ec

Table S2: *Links to examples for features erroneously classified as glacier in TLMglac. Cases a)-f) correspond to Figure 4 of the main article, cases g)-m) are additional examples. The coordinates (X, Y) refer to the Swiss reference system CH1903+/LV95.*

Case	*Glacier name / Location*	*X*	*Y*	*Link*
a)	Glacier du Brenay	2'596'667.5	1'089'370.0	https://s.geo.admin.ch/8d5442443c
b)	Pointe des Plines	2'569'358.0	1'092'348.0	https://s.geo.admin.ch/8d544bb807
c)	Ghiacciaoa di Pesciora	2'679'314.0	1'152'246.0	https://s.geo.admin.ch/8d544cb072
d)	Findelengletscher	2'630'750.0	1'095'390.0	https://s.geo.admin.ch/8d544dad6a
e)	Unteraargletscher	2'658'482.5	1'157'040.0	https://s.geo.admin.ch/8d544e53db
f)	Bec des Etagnes	2'590'765.0	1'103'310.0	https://s.geo.admin.ch/8d54549472
g)	Pointe des Plines	2'569'358.0	1'092'348.0	https://s.geo.admin.ch/8d544bb807
h)	Plaine Morte	2'604'482.0	1'137'826.0	https://s.geo.admin.ch/8d54519070
i)	Glacier des Fonds	2'559'032.5	1'107'747.5	https://s.geo.admin.ch/8d54520671
j)	Murmelsbiel	2'684'948.0	1'181'126.0	https://s.geo.admin.ch/8d54527f46
k)	Hangendegletscher	2'628'096.0	1'136'832.0	https://s.geo.admin.ch/8d5452fb98
l)	Marchhorn	2'679'585.0	1'145'052.5	https://s.geo.admin.ch/8d54535ad5
m)	Gornergletscher	2'625'440.0	1'091'830.0	https://s.geo.admin.ch/8d5453dd70

Table S3: *Classification principles to build a unique glacier identifier (SGI-ID) shown for the example of Tiefengletscher (Central Swiss Alps). SGI-IDs are organized as an alphanumeric four-digit code according to a hydrological, hierarchical classification principle with river-levels. The first-order hydrological subdivision of Switzerland (i.e. the first digit) corresponds to the major river catchments and is designated by capital letters (rl_0: A-E, cf. Figure 1). The second and third digits of the code are represented by numbers and correspond to the catchment areas of major and medium-sized tributaries (rl_1; rl_2). The subdivision into headstreams (small tributaries, rl_3) represents the fourth digit. Finally, the SGI-ID is completed with a sequential number for glaciers within a specific inventory region (i-code).*

SGI code levels		*SGI-ID*	*SGI-names*
river level 0	rl_0	A	Rhein
river level 1	rl_1	A5	Aare
river level 2	rl_2	A51	Reuss
river level 3	rl_3	A51e	Urserental
inventory-code	i-code	A51e-37	Tiefengletscher

Table S4: *Attributes of the SGI2016 including their description.*

Attribute	*Description*
[gid]:	geometry-ID
[pk_glacier]:	uuid for internal use
[sgi-id]:	Swiss Glacier Inventory ID: [rl_0,rl_1,rl_2,rl_3]-[i_code] (i.e. A54e-24)
[name]:	name of glacier (if available, i.e. 'Triftgletscher')
[rl_0]:	Riverlevel_0: Subdivision of the inventory area on the basis of catchment areas of major rivers (i.e. A)
[rl_1]:	Riverlevel_1: Subdivision of the inventory area on the basis of catchment areas of major tributaries (i.e. 5)
[rl_2]:	Riverlevel_2: Subdivision of the inventory area on the basis of catchment areas of medium-sized tributaries (i.e. 4)
[rl_3]:	Riverlevel_3: Subdivision of the inventory area on the basis of catchment areas of small tributaries (i.e. e)
[i_code]:	Inventory Code: Sequential number for glacier within a specific inventory region (i.e. 24)
[year_acq]:	Year of acquisition of the aerial image used for glacier mapping
[year_rel]:	Year of release of Swiss Glacier Inventory
[area_km2]:	area in square kilometres
[length_km]:	length of glacier according to Machguth and Huss (2014)
[masl_min]:	minimum of meter above sea level based on swissALTI3D release 2019
[masl_mean]:	mean of meter above sea level based on swissALTI3D release 2019
[masl_med]:	median of meter above sea level based on swissALTI3D release 2019
[masl_max]:	maximum of meter above sea level based on swissALTI3D release 2019
[slope_deg]:	average of slope in degree based on swissALTI3D release 2019
[aspect_deg]:	average of aspect in degree based on swissALTI3D release 2019

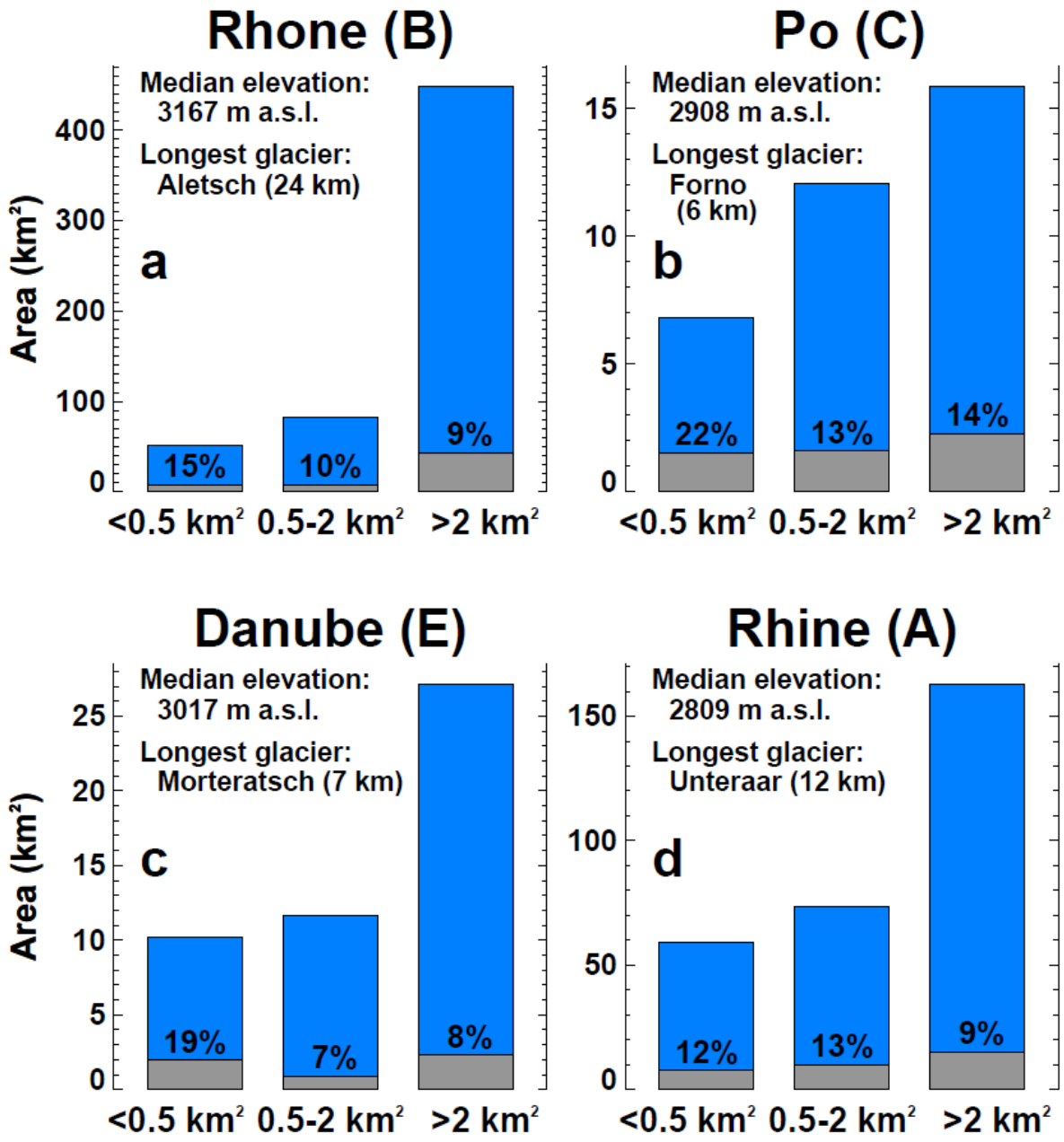

Figure S1: *Area distribution of three glacier size classes per major river catchment. Bars show the total area covered by glaciers, subdivided into clean ice (blue) and debris-covered (grey) parts (ratio for debris cover indicated with %). For each catchment, the median glacier elevation and the longest glacier are stated in the panel.*

Table S5: *Detailed information for glaciers displayed in Figure 11 of the main article, illustrating general cases of reassessed glacier outlines for the time of the SGI2010. ΔA represents the difference in area (km²) between SGI2010 and the re-assessment in SGI2010_ref.*

			Area (km²)			
Fig.	*SGI-ID*	*Glacier name*	*SGI2010*	*2010_ref*	*ΔA*	*SGI2016*
11a)	B74-22	Glacier d'Orchère	0.012	0.035	0.023	0.036
11b)	B84-21	Glacier de Valsorey	1.880	2.076	0.196	1.958
11c)	A14c-03	Fanellgletscher	0.827	0.901	0.074	0.807
11d)	C02-02	Bodmergletscher	0.326	0.482	0.156	0.505

Table S6: *Comparison of glacier areas for the round robin experiment on multiple digitization of 15 glaciers by five experts. Glaciers are ordered according to increasing glacier area. Minimum, mean and maximum digitized area based on the same imagery is given and the standard deviation (stdev) relative to mapped average area is evaluated.*

		15 Glacier round robin experiment			
		Area			stdev
SGI-ID	*Glacier name*	*min. (km²)*	*mean (km²)*	*max. (km²)*	*(%)*
C46-03	Ghiacciaio di Basso	0.058	**0.089**	0.111	23.8
B35-02	Gredetschgletscher E	0.145	**0.156**	0.169	7.1
A12d-10	Ducangletscher	0.217	**0.222**	0.229	2.2
E35-19	Vadret d'Err S	0.322	**0.345**	0.381	6.5
B51-12	Triftgletscher NE (Saas Grund)	0.415	**0.444**	0.469	5.8
A50i-17	Sandfirn E	0.372	**0.416**	0.436	6.1
B72-08	Glacier de la Dent Blanche	1.068	**1.106**	1.147	2.6
A54e-13	Steilimigletscher	1.521	**1.549**	1.608	2.6
B90-04	Glacier des Grands	1.540	**1.570**	1.599	1.4
C05-02	Alpjergletscher	2.193	**2.255**	2.367	3.0
B22-01	Glacier de Tsanfleuron	2.668	**2.677**	2.686	0.3
A51f-10	Dammagletscher	4.070	**4.100**	4.123	0.5
E23-06	Vadret da Tschierva	5.408	**5.483**	5.762	2.8
B63-05	Glacier de Zinal	13.089	**13.314**	13.603	1.9
A54g-11	Unteraargletscher	21.111	**22.155**	22.780	2.9

Table S7: *Uncertainty assessment for three size classes based on the 15 glaciers from the digitization experiment, resulting in an overall uncertainty range.*

	SGI2016	Uncertainty	
Size class	Area (km²)	stdev (%)	abs. (km²)
0-0.5 km²	127.4	4.2	±5.4
0.5-5 km²	180.0	1.1	±2.1
>5 km²	653.9	2.2	±14.3
Total	**961.3**	**2.3**	**±21.8**

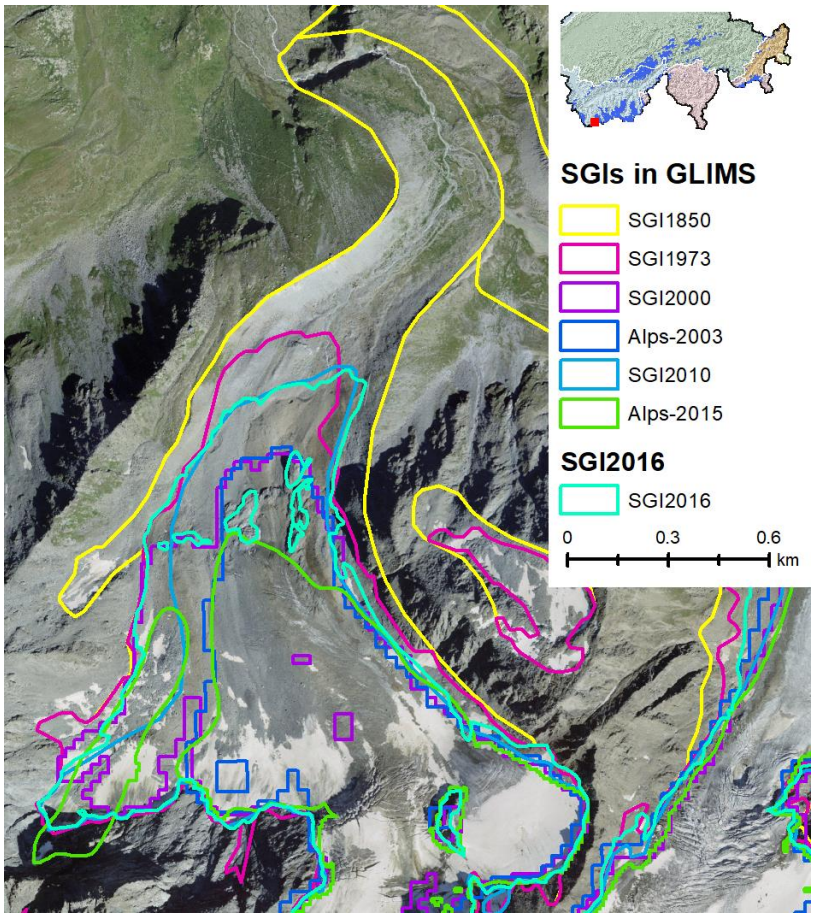

Figure S2: *Compilation of glacier outlines from previous inventories available via the GLIMS database together with the SGI2016 for the example of Glacier du Tseudet, Valais. In the background, a SWISSIMAGE orthophoto acquired in 2020 is shown. The location within Switzerland is indicated in the inset (red rectangle).*

Table S8: *Number of glaciers and area mapped for all inventories covering the Swiss Alps categorized into seven glacier size classes and the major river catchments (A, B, C, E) as well as the total for Switzerland (CH).*

Size class (km2)		SGI1850					SGI1973					SGI2000					Alps-2003					SGI2010					up-	Alps-2015					SGI2016				
		A	B	C	E	CH	A	B	C	E	CH	A	B	C	E	CH	A	B	C	E	CH	A	B	C	E	CH	scaled	A	B	C	E	CH	A	B	C	E	CH
<0.1	Number	351	403	68	26	**848**	721	582	170	223	**1696**	889	801	88	87	**1865**	1325	1041	170	184	**2720**	418	312	46	51	**827**	**827**	507	510	95	84	**1196**	345	275	47	59	**726**
	Number %	*36*	*47*	*38*	*14*	***38***	*62*	*59*	*68*	*68*	***62***	*73*	*72*	*69*	*64*	***72***	*81*	*78*	*80*	*79*	***79***	*60*	*55*	*55*	*53*	***57***	***57***	*67*	*63*	*65*	*64*	***65***	*54*	*48*	*56*	*55*	***52***
	Area (km2)	14	14	3	2	**32**	24	20	5	5	**54**	14	11	2	2	**29**	17	13	3	3	**36**	13	10	1	2	**26**	**41**	16	16	3	3	**39**	14	11	2	3	**30**
	Area %	*2*	*2*	*3*	*1*	***2***	*6*	*3*	*8*	*6*	***4***	*3*	*2*	*4*	*4*	***3***	*4*	*3*	*7*	*5*	***3***	*4*	*2*	*4*	*5*	***3***	***4***	*9*	*3*	*7*	*7*	***4***	*5*	*2*	*5*	*5*	***3***
0.1-0.5	Number	386	240	64	113	**803**	309	232	59	79	**679**	203	177	21	34	**435**	202	160	25	32	**419**	179	136	24	32	**371**	**371**	179	166	31	33	**409**	192	172	22	34	**420**
	Number %	*40*	*28*	*36*	*59*	***36***	*26*	*24*	*24*	*24*	***25***	*17*	*16*	*17*	*25*	***17***	*12*	*12*	*12*	*14*	***12***	*26*	*24*	*29*	*33*	***26***	***26***	*24*	*20*	*21*	*25*	***22***	*30*	*30*	*26*	*32*	***30***
	Area (km2)	95	58	15	28	**196**	70	54	13	18	**154**	47	41	5	8	**101**	47	38	5	7	**98**	40	33	5	7	**86**	**102**	41	40	7	7	**94**	45	40	5	8	**98**
	Area %	*15*	*6*	*15*	*21*	***11***	*16*	*7*	*20*	*22*	***12***	*10*	*9*	*14*	*15*	***10***	*10*	*8*	*14*	*14*	***9***	*14*	*6*	*16*	*15*	***9***	***10***	*24*	*6*	*17*	*15*	***11***	*15*	*7*	*14*	*15*	***10***
0.5-1	Number	111	78	25	28	**242**	67	58	10	12	**147**	59	44	8	7	**118**	52	46	8	9	**115**	41	36	4	6	**87**	**87**	33	49	9	5	**96**	45	37	5	7	**94**
	Number %	*11*	*9*	*14*	*15*	***11***	*6*	*6*	*4*	*4*	***5***	*5*	*4*	*6*	*5*	***5***	*3*	*3*	*4*	*4*	***3***	*6*	*6*	*5*	*6*	***6***	***6***	*4*	*6*	*6*	*4*	***5***	*7*	*6*	*6*	*7*	***7***
	Area (km2)	76	54	17	19	**166**	47	38	7	9	**102**	41	32	6	5	**84**	36	33	6	6	**81**	28	26	3	4	**62**	**68**	22	35	6	3	**66**	32	28	3	5	**67**
	Area %	*12*	*6*	*17*	*14*	***9***	*11*	*5*	*12*	*10*	***8***	*9*	*7*	*16*	*9*	***8***	*8*	*7*	*15*	*12*	***8***	*10*	*5*	*8*	*9*	***7***	***7***	*13*	*5*	*15*	*7*	***7***	*11*	*5*	*10*	*10*	***7***
1-2	Number	68	61	11	14	**154**	35	52	6	5	**98**	28	42	6	4	**80**	31	41	5	3	**80**	26	36	6	4	**72**	**72**	22	36	9	5	**72**	30	38	6	4	**78**
	Number %	*7*	*7*	*6*	*7*	***7***	*3*	*5*	*2*	*2*	***4***	*2*	*4*	*5*	*3*	***3***	*2*	*3*	*2*	*1*	***2***	*4*	*6*	*7*	*4*	***5***	***5***	*3*	*4*	*6*	*4*	***4***	*5*	*7*	*7*	*4*	***6***
	Area (km2)	93	89	16	19	**217**	51	73	10	6	**140**	41	58	8	5	**113**	44	56	7	5	**112**	37	51	8	7	**103**	**110**	32	49	13	8	**101**	42	55	9	7	**113**
	Area %	*15*	*10*	*16*	*14*	***12***	*12*	*10*	*16*	*7*	***11***	*9*	*12*	*21*	*10*	***11***	*9*	*12*	*19*	*9*	***11***	*13*	*9*	*25*	*14*	***11***	***11***	*19*	*8*	*32*	*16*	***11***	*14*	*10*	*25*	*14*	***12***
2-5	Number	40	43	10	8	**101**	23	27	4	4	**58**	22	20	2	1	**45**	18	21	2	1	**42**	16	21	2	0	**39**	**39**	7	21	3	2	**33**	15	19	2	0	**36**
	Number %	*4*	*5*	*6*	*4*	***5***	*2*	*3*	*2*	*1*	***2***	*2*	*2*	*2*	*1*	***2***	*1*	*2*	*1*	*0*	***1***	*2*	*4*	*2*	*0*	***3***	***3***	*1*	*3*	*2*	*2*	***2***	*2*	*3*	*2*	*0*	***3***
	Area (km2)	122	126	29	28	**306**	66	75	11	10	**162**	60	60	5	2	**127**	50	65	5	2	**122**	49	64	5	0	**117**	**125**	20	71	11	7	**109**	42	56	4	0	**103**
	Area %	*20*	*13*	*30*	*21*	***17***	*15*	*10*	*19*	*13*	***12***	*13*	*13*	*13*	*4*	***12***	*11*	*13*	*13*	*4*	***12***	*17*	*11*	*14*	*0*	***12***	***12***	*12*	*11*	*29*	*14*	***12***	*14*	*10*	*13*	*0*	***11***
5-10	Number	8	16	1	1	**26**	11	19	2	2	**34**	7	18	2	2	**29**	6	18	2	2	**28**	7	16	2	2	**27**	**27**	4	23	0	1	**28**	7	16	2	2	**27**
	Number %	*1*	*2*	*1*	*1*	***1***	*1*	*2*	*1*	*1*	***1***	*1*	*2*	*2*	*1*	***1***	*0*	*1*	*1*	*1*	***1***	*1*	*3*	*2*	*2*	***2***	***2***	*1*	*3*	*0*	*1*	***2***	*1*	*3*	*2*	*2*	***2***
	Area (km2)	56	124	8	8	**197**	73	136	16	16	**240**	52	119	12	14	**198**	46	121	12	14	**193**	49	113	12	12	**185**	**191**	28	158	0	7	**193**	48	106	11	12	**178**
	Area %	*9*	*13*	*8*	*6*	***11***	*17*	*18*	*25*	*19*	***18***	*11*	*25*	*32*	*27*	***19***	*10*	*25*	*33*	*26*	***19***	*17*	*20*	*34*	*25*	***20***	***19***	*16*	*25*	*0*	*13*	***22***	*16*	*18*	*33*	*25*	***19***
>10	Number	9	18	1	2	**30**	6	13	0	1	**20**	9	8	0	1	**18**	9	8	0	1	**18**	5	12	0	1	**18**	**18**	1	11	0	1	**13**	5	13	0	1	**19**
	Number %	*1*	*2*	*1*	*1*	***1***	*1*	*1*	*0*	*0*	***1***	*1*	*1*	*0*	*1*	***1***	*1*	*1*	*0*	*0*	***1***	*1*	*2*	*0*	*1*	***1***	***1***	*0*	*1*	*0*	*1*	***1***	*1*	*2*	*0*	*1*	***1***
	Area (km2)	163	469	11	30	**673**	97	344	0	17	**459**	220	155	0	16	**390**	225	157	0	16	**398**	74	277	0	15	**365**	**373**	11	262	0	14	**288**	73	285	0	15	**373**
	Area %	*26*	*50*	*11*	*23*	***38***	*23*	*47*	*0*	*21*	***35***	*46*	*33*	*0*	*31*	***38***	*48*	*32*	*0*	*30*	***38***	*25*	*48*	*0*	*31*	***39***	***37***	*7*	*42*	*0*	*29*	***32***	*25*	*49*	*0*	*30*	***39***
Total	**Number**	**973**	**859**	**180**	**192**	**2204**	**##**	**##**	**251**	**##**	**2732**	**##**	**##**	**127**	**136**	**2590**	**##**	**##**	**212**	**##**	**3422**	**##**	**569**	**84**	**96**	**1441**	**1441**	**753**	**816**	**147**	**131**	**1847**	**##**	**570**	**84**	**107**	**1400**
	Area (km2)	**619**	**935**	**98**	**135**	**1788**	**##**	**740**	**62**	**81**	**1311**	**475**	**477**	**37**	**51**	**1041**	**##**	**485**	**37**	**53**	**1041**	**##**	**573**	**34**	**48**	**944**	**1009**	**170**	**631**	**39**	**50**	**890**	**295**	**582**	**35**	**49**	**961**